Controlling GUI elements with a DJ Deck: Effects of prior experience on physical interface performance

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ABSTRACT
A prototype system introduced by Groth & Shamma [4] showed that a audio mixing deck can be used to filter and integrate data from social media streams. This article further investigates the possibility to use disc jockey (DJ) mixing boards as input device for graphical user interfaces (GUIs). In the presented experiment the type of physical interfaces disc jockeys (DJs) typically use are combined with common GUI elements, testing the assumption that mixing boards can effectively control graphical user interface elements. A user study will evaluate how the input device is being used by various user groups with differing amounts of experience with DJ decks or other physical interfaces. The gathered insights will be feeded back into the design of the prototype system.

Author Keywords
Input devices, Physical Interfaces, DJ Mixing Board, prior experience, Post-WIMP, user study.

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

1. INTRODUCTION
This article will examine the possibilities of controlling graphical user interfaces using a specialized input device. Mixing boards are commonly used by disc jockeys (DJs) to mix and manipulate music streams, the present study investigates how effective this input device can be used to control common GUI elements.

The first section will present a brief history of human computer interaction (HCI) paradigms and input devices. Followed by an introduction to physical user interfaces in general and a demonstration of the DJ deck as an input device for our prototype system. The final part of this section will introduce the scientific questions to be answered by this paper. Followed by the method section that demonstrates the techniques used to answer our research questions. The final section of this article will describe our personal expectations regarding the outcome of this research.

1.1 HCI Interaction models:

1.1.1 WIMP
WIMP (Windows, Icons, Menus, and a Pointer) interfaces initially started with simple principles: Spatial divisions by using rectangles (i.e., Windows), unused items can be represented by small icons, command controls can be replaced by menus, and pointer interaction allows movement between spatially separated interface items. WIMP interfaces have been very successful commercially and have reached a broad range of audiences for a wide range of applications by providing simple, easy-to-learn, and easy-to-use "point-and-click" interaction.

1.1.2 Direct Manipulation
In the early eighties, Shneiderman developed a model called direct manipulation that can be characterized by four principles: The object of interest should always be present, physical actions (e.g. movement and selection with an input device) instead of complex syntax, rapid, incremental, and reversible operations with an immediately-apparent effect on the objects of interest, and incremental approach to learning that permits usage with minimal knowledge and an expansion to more complex interactions. Direct manipulation [6] has been well accepted as an efficient and easily-learned means of manipulating objects in graphical user interfaces. Users directly manipulate graphical objects by pointing, selecting, and dragging, taking advantage of natural human abilities to manipulate objects. Users of direct manipulation interfaces experience less anxiety, feel more in control, and become more engaged in their tasks [7].

Direct manipulation is not tethered to WIMP interfaces and therefore it has been applied to other types of interfaces including post-WIMP. However, due to the dominant use of mouse and keyboard for the traditional desktop environment, direct manipulation has often been tightly coupled with WIMP interfaces. They together have dominated the interface design world and remain the most predominant interaction paradigms.

1.1.3 Post-WIMP
A few researchers have promoted the development of a next generation of interfaces called post-WIMP interfaces. In 1993, Nielsen first suggested these to be non-command interfaces, which may go beyond the standard WIMP paradigm to involve elements like virtual realities, sound and speech, pen and gesture recognition, instrumental interaction, proxemics and touch-based.

A few years later, van Dam defined post-WIMP as interfaces "containing at least one interaction technique not dependent on classical 2D widgets such as menus and icons". Not surprisingly, over the last two decades, a significant amount of research has been conducted to develop new interfaces that diverge from WIMP and/or direct manipulation.

1.1.4 Post Direct Manipulation

While there has not been a model referred to as post direct manipulation, there has been a series of efforts to expand and refine the idea of direct manipulation. To encompass the wide range of emerging graphical interaction techniques, Beaudouin-Lafon introduced a new interaction model, called instrumental interaction, which extends and generalizes the principles of direct manipulation. It is inspired by the way we use instruments to manipulate objects of interest in the physical world. Jacob et al. proposed a framework, called Reality-based Interaction, which tried to unify emerging post-WIMP interaction techniques. Their underlying motivation is that the new interaction techniques draw strength by building on people's knowledge of the everyday, non-digital world to a much greater extent than before. Their framework focuses specifically on the following four themes from the real world: *Naïve Physics*: people have common sense knowledge about the physical world, *Body Awareness & Skills*: people have an awareness of their own physical bodies and possess skills for controlling and coordinating their bodies, *Environmental Awareness & Skills*: people have a sense of their surroundings and possess skills for negotiating, manipulating, and navigating within their environment, and *Social Awareness & Skills*: people are generally aware of others in their environment and have skills for interacting with them.

1.2 Input Devices

The previous section shows there is a great amount of research directed towards HCI models. This section will examine input devices because they are central to every known HCI model.

Since the early eighties human computer interaction is centered around the use of a keyboard and mouse combined with a graphical user interfaces. The popularity of touch sensitive interfaces, referred to in the media as Natural User Interfaces (NUIs), does have changed the way interface elements look and function to some extend. Note that touch is a type of pointing device just like the computer mouse, instead of an HCI model. So although the use of touch sensitive screens for pointing, the WIMP GUIs (graphical user interfaces based on windows, icons, menus, and a pointer) paradigm is still dominating the notion of HCI for personal computer use.

1.2.1 'Graspable' interfaces

Since humans learned to use advanced tools and started to make machines, moving handles, levers, and valves became common ways to interact with these machines. With the introduction of electronics the same mechanical controls evolved to switches, knobs and buttons. When technological development continued, physical controls were increasingly represented by virtual sliders and buttons (as commonly found in GUIs).

Because of the dynamic and non-physical nature of these GUI components, the controls are less affected by temporal and spatial constraints. Meaning that one physical input device can manipulate more than one virtual objects. This resulted in one generic input device such as a mouse controlling multiple graphic interface widgets. Common widget-based GUI applications require the user to first acquire the mouse, then move the mouse pointer to acquire a control widget, and then manipulate the widget by means of moving the mouse. Such interactions are much less direct than using specialized input devices. This can disrupt the user's experience of direct manipulation. For example, scrolling a document using a mouse wheel feels more direct than manipulating a graphic scroll bar, because the scroll wheel is directly at hand and does not have to be explicitly acquired. In this way, generic input devices can break the flow of a user's cognitive engagement with the task, negatively impacting performance [2]. Specialized input devices that match the control structure of the task may alleviate this problem.

Strong arguments can be made for using specialized physical devices for computer input. Research has shown that for a variety of applications, specialized physical input devices outperform equivalent graphical widgets. For example, Fitzmaurice and Buxton [3] demonstrated that physical or "graspable" user interfaces with specialized shapes and dedicated functions were superior to a generic input device for a target tracking task. Hunt and Kirk [5] conducted an experiment comparing physical and virtual sliders for setting sound parameters. Participants achieved better results on a target sound matching task using physical sliders. Similarly, Chipman et al. [1] compared a physical slider, a graphical scrollbar, and the mouse wheel for two scrolling tasks. Both physical interfaces performed better than the graphical scrollbar, with the mouse wheel being superior for searching and the physical slider being superior for reciprocal tapping.

In this article we propose using an audio mixing board as an input device to control GUI elements. Physical sliders, buttons, and knobs on the mixing board are mapped to virtual controls in the GUI. The presented experiment will examine the effectiveness of using a mixing board to control GUI elements. Learning effects will also be examined by taking in account the users prior experience with a DJ mixing board or specialized physical interfaces in general.

2. Method

2.1 Participants

This experiment will use participants from different backgrounds (e.g. DJs, producers, composers, VJs, Video editors, 2D/3D Designers and normal computer users. The participants will be divided into groups based on how experienced they are with certain types of physical interfaces.

2.2 Data

Data will be gather from these participants by using structured interviews, self-report questionnaires and quantitative performance measurements. Data will be gathered before the participants have used the physical interface **(1)**. While they use the physical interface **(2)**, and after they have used the physical interface **(3)**.

1a) Questionnaire/Interview: Awareness of interface types and attitude towards physical interfaces:
- Frequency and intensity of computer use in general?
- Can they imagine using a physical interface?
- Do they expect it to be useful?

1b) Questionnaire/Interviews: Explore the current usage of physical interfaces in practice.
- In what fields are physical interfaces currently used?
- Why are they used, in these fields? (map the needs and characteristics of that field to cons. of physical interfaces)
- How are these interfaces currently used in practice?

2) Benchmark: Performance when using the physical interface
- Learning curve (can this be connected to previous experience)
- Mistakes made
- Successful operations
- Favorite operations

3) Questionnaire/Interview: User experience after using the physical interface.
- Ease of use
- Perceived learning curve
- Willingness to use the physical interface again

2.3 Tasks

After conducting the interview and filling in the questionnaire at time **(1a,b)**. The participants are asked to execute two tasks, one is a scrolling task and the other a search task. For the scrolling task a vertical menu is visible on screen listing song titles. Only 10% of the complete list is visible at one time, the control wheel on the DJ deck is used to navigate through the complete list. Of all the song titles in the complete list one title is randomly highlighted. The task is to navigate through the list and select the highlighted song title as fast as possible.

The second task is a search task, here the same vertical menu listing song titles is visible on screen. For this task no song titles are highlighted. Instead, the participant is randomly shown one song title. The task is to find and select this song title from the list as quick as possible by navigating through the menu using the control wheel of the DJ deck.

3. Expected outcome

We expect his study can identify:

- How and why physical interfaces are currently used and can be used.
- How and why are mixing boards currently used by various user groups?
- Knowledge about common attitudes towards physical interfaces.
- For what types of tasks, interfaces, or data types are physical interfaces likely to be useful?
- In what settings are physical interfaces likely to be useful?
- The effect of prior experience on task performance.
- Typical learning curves for task performance.
- New insights on how people use the mixing board.
- New tasks and types of data that can be used in combination with a mixing board.

And possibly also:

- If there is a compromises between specialized interfaces for high performance and more generic interfaces at the expense of performance?

4. REFERENCES

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Appendix 1: PLANNING

Week	Date	Mon	Thu	Wed	Thur	Fri
14	**31 mrt**	rewrite intro		make questionaire		
15	**7 apr**		rewrite method			
16	**14 apr**	make interview		rewrite method		
17	**21 apr**		make task 1			
18	**28 apr**					
19	**5 may**		make task 2			
20	**12 may**	find participants	find participants			
21	**19 may**			experiment	experiment	experiment
22	**26 may**	experiment	gether results	data analysis	data analysis	write results
23	**2 jun**	write conclusion			write discussion	
24	**9 jun**	finalize report				
25	**16 jun**	presentation				
26	**23 jun**					defence
27	**30 jun**					defence
28	**7 jul**					defence
29	**14 jul**					defence
30	**21 jul**					defence

Color Legend:
Questionnaire & interview: Amber
Writing: Blue
Task design: Green
Experiment: Red
Presentation: Purple